WHAT IS CLAIMED IS:

1. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

oxidizing a patterned hard mask to form a surface oxide thereon; and

etching an MTJ stack in alignment with the patterned hard mask after the oxidizing of the patterned hard mask.

2. The method of claim 1, wherein the hard mask comprises a layer made from a material selected from a group consisting of titanium, tantalum, tantalum nitride, titanium nitride, titanium oxide, and tantalum oxide.

3. The method of claim 1, wherein the hard mask comprises:

a tantalum nitride layer;

a titanium layer over the tantalum nitride layer; and

a titanium nitride layer over the titanium layer.

4. The method of claim 1, wherein the etching of the MTJ stack is performed with an etch chemistry comprising oxygen and chlorine.

5. The method of claim 4, wherein the etching of the MTJ stack is performed using a self-bias voltage between about –350 and about –380 volts.

6. A magnetic tunnel junction (MTJ) device, comprising:

an MTJ stack;

a tantalum nitride layer over the MTJ stack;

a titanium layer over the tantalum nitride layer; and

a titanium nitride layer over the titanium layer.

7. A magnetic tunnel junction (MTJ) device, comprising:

an MTJ stack;

a titanium layer over the MTJ stack; and

a titanium nitride layer over the titanium layer.

8. The MTJ device of claim 7, further comprising:

a tantalum nitride layer over the MTJ stack, wherein the titanium layer is over the tantalum nitride layer.

9. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

providing a hard mask over an MTJ stack;

providing a patterned photoresist layer over the hard mask;

etching through a first thickness of the hard mask, the first thickness being less than an entire thickness for the hard mask;

removing the photoresist layer after etching through the first thickness of the hard mask; and

etching through a remaining thickness of the hard mask after removing the photoresist layer.

10. The method of claim 9, wherein the hard mask comprises:

a tantalum nitride layer;

a titanium layer over the tantalum nitride layer; and

a titanium nitride layer over the titanium layer.

11. The method of claim 9, further comprising:

providing an ARC layer between the hard mask and the photoresist layer; and

etching through the ARC layer.

12. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

providing a hard mask over an MTJ stack, the hard mask comprising a titanium nitride layer over a titanium layer;

providing a patterned photoresist layer over the hard mask;

etching through a majority of the titanium nitride layer with a first etch recipe;

etching through a remainder of the titanium nitride layer and a first portion of the titanium layer with a second etch recipe; and

removing the photoresist layer.

13. The method of claim 12, wherein the hard mask further comprises a tantalum nitride layer, wherein the titanium layer is over the tantalum nitride layer, the method further comprising:

after removing the photoresist layer, etching through a remainder of the titanium layer and at least a majority of the tantalum nitride cap layer with a third etch recipe; and

oxidizing the titanium nitride layer, the titanium layer, and the tantalum nitride cap layer to form a surface oxide thereon.

14. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

providing an initial structure comprising:

an underlying layer;

a bottom tantalum nitride layer over the underlying layer,

a tantalum layer over the bottom tantalum nitride layer,

an MTJ stack over the tantalum layer,

a tantalum nitride cap layer over the MTJ stack,

a titanium layer over the tantalum nitride cap layer,

a titanium nitride layer over the titanium layer, and

a patterned photoresist layer over the titanium nitride layer;

etching through a majority of the titanium nitride layer with a first etch recipe;

etching through a remainder of the titanium nitride layer and a first portion of the titanium layer with a second etch recipe;

removing the photoresist layer;

etching through a remainder of the titanium layer and at least a majority of the tantalum nitride cap layer with a third etch recipe;

oxidizing the titanium nitride layer, the titanium layer, and the tantalum nitride cap layer to form a surface oxide thereon;

etching the MTJ stack with a fourth etch recipe; and

etching the tantalum layer and the bottom tantalum nitride layer with a fifth etch recipe.

15. The method of claim 14, further comprising:

rinsing with de-ionized water after etching the bottom tantalum nitride layer.

16. The method of claim 14, wherein the underlying layer is an insulating material having a conducting line formed therein.

17. The method of claim 16, wherein the insulating material is SiO_2, and wherein the conducting line comprises a liner layer and a copper line.

18. The method of claim 14, wherein the MTJ stack comprises:

a platinum manganese layer;

a cobalt iron layer over the platinum manganese layer;

an aluminum oxide layer over the cobalt iron layer; and

a nickel iron layer over aluminum oxide layer.

19. The method of claim 14, wherein the etching through the majority of the titanium nitride layer goes through about 90% of a total thickness of the titanium nitride layer.

20. The method of claim 14, wherein the first etch recipe comprises a flow of at least one of Cl_2 and NF_3.

21. The method of claim 20, wherein the first etch recipe comprises:

a flow of Cl_2 at about 40 sccm;

a flow of NF_3 at about 4 sccm;

a plasma source power of about 2000 watts;

a plasma bias power of about 220 watts; and

a pressure of about 2.5 mTorr.

22. The method of claim 14, wherein the second etch recipe comprises a fluorine-based etch chemistry.

23. The method of claim 22, wherein the second etch recipe comprises:

a flow of CF_4 at about 10 sccm;

a flow of CHF_3 at about 5 sccm;

a flow of Ar at about 60 sccm;

a plasma source power of about 1000 watts;

a plasma bias power of about 100 watts; and

a pressure of about 2.5 mTorr.

24. The method of claim 14, wherein the removing of the photoresist layer is performed using a flow of at least one of O_2 and Ar.

25. The method of claim 14, wherein the removing of the photoresist layer is performed before the etching with the third etch recipe.

26. The method of claim 14, wherein the third etch recipe comprises a fluorine-based etch chemistry.

27. The method of claim 26, wherein the third etch recipe comprises:

a flow of CF_4 at about 10 sccm;

a flow of CHF_3 at about 5 sccm;

a flow of Ar at about 60 sccm;

a plasma source power of about 1000 watts;

a plasma bias power of about 100 watts; and

a pressure of about 2.5 mTorr.

28. The method of claim 14, wherein the oxidizing to form the surface oxide is a plasma oxidation performed under conditions comprising:

a flow of O_2 at about 50 sccm;

a flow of Ar at about 50 sccm;

a plasma source power of about 1500 watts;

a plasma bias power of about 25 watts; and

a pressure of about 5 mTorr.

29. The method of claim 14, wherein the surface-oxidized titanium nitride, titanium, and tantalum nitride cap layers provide a hard mask structure for the etching of the MTJ stack.

30. The method of claim 14, wherein the fourth etch recipe comprises a flow of at least one of Cl_2, O_2, and Ar.

31. The method of claim 30, wherein the fourth etch recipe comprises:

a flow of Cl_2 at about 40 sccm;

a flow of O_2 at about 10 sccm;

a flow of Ar at about 20 sccm;

a plasma source power of about 2500 watts;

a plasma bias power of about 250 watts; and

a pressure of about 2.5 mTorr.

32. The method of claim 31, wherein the fourth etch recipe further comprises:

a self-bias voltage between about –350 and about –380 volts.

33. The method of claim 14, wherein the fifth etch recipe comprises a fluorine-based etch chemistry.

34. The method of claim 33, wherein the fifth etch recipe comprises:

a flow of CF_4 at about 60 sccm;

a flow of O_2 at about 5 sccm;

a flow of Ar at about 10 sccm;

a plasma source power of about 1000 watts;

a plasma bias power of about 100 watts; and

a pressure of about 2.5 mTorr.

35. The method of claim 34, wherein the fifth etch recipe further comprises:

a self-bias voltage between about –90 and about –110 volts.

36. The method of claim 14, further comprising:

over-etching with the fifth etch recipe to remove up to about 90 nm of the underlying layer.

37. The method of claim 14, wherein the initial structure further comprises a patterned ARC layer located between the photoresist layer and the titanium nitride layer, and wherein the removing of the photoresist layer also removes the ARC layer.

38. The method of claim 14, wherein at least one of the tantalum layer and the bottom tantalum nitride layer are oxidized upon exposure to the fourth etch recipe.

39. The method of claim 14, wherein an end point for the etching of the MTJ stack with the fourth etch recipe is measured with an end point function selected from a group consisting of

optical emission spectroscopy, residual gas analysis, laser interferometry, interferometric end point, and full wafer imaging interferometry.

40. The method of claim 14, wherein the etching of the MTJ stack with the fourth etch recipe is a timed etch.

41. The method of claim 14, wherein the etching of the MTJ stack with the fourth etch recipe is extended as an overetch for an etch time between 0 and about 1000 seconds to remove redeposited material from sidewalls of the MTJ stack to prevent shorting across a tunnel barrier layer of the MTJ stack.

42. The method of claim 14, wherein timing for the etching with the fifth etch recipe is adjusted to remove redeposited materials from sidewalls of the MTJ stack to prevent shorting across a tunnel barrier layer of the MTJ stack.

43. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

etching an MTJ stack using an MTJ etch chemistry at a total flow rate, and the total flow rate of the MTJ etch chemistry comprising a chlorine flow rate, an oxygen flow rate, and an argon flow rate, wherein the chlorine flow rate is about 20-60% of the total flow rate, the oxygen flow rate is about 10-40% of the total flow rate, and the argon flow rate is about 20-35% of the total flow rate.

44. The method of claim 43, wherein the chlorine flow rate is about 40 sccm, the oxygen flow rate is about 10 sccm, and the argon flow rate is about 20 sccm.

45. The method of claim 43, wherein process parameters for the etching of the MTJ stack comprise:

a source power of about 2500 watts;

a bias power of about 250 watts;

a pressure of about 2.5 mTorr; and

a self-bias voltage between about –350 and –380 volts.

46. The method of claim 43, further comprising:

providing a stack of initial layers over an underlying layer, wherein the stack of initial layers comprises a photoresist layer, a hard mask, and the MTJ stack, the photoresist being over the hard mask, and the hard mask being over the MTJ stack;

etching the hard mask to form a hard-mask pattern therein in alignment with a resist pattern formed in the photoresist layer;

stripping the photoresist layer using a resist-strip plasma comprising oxygen; and

oxidizing exposed surfaces of the hard mask during the stripping of the photoresist layer.

47. The method of claim 46, further comprising:

oxidizing exposed surfaces of the hard mask after the stripping of the photoresist layer.

48. The method of claim 43, wherein the etching of the MTJ stack is performed in a high-density plasma reactor.

49. The method of claim 43, wherein the total flow rate is between about 50 and about 500 sccm.

50. The method of claim 43, wherein the chlorine flow rate substantially consists of Cl_2, the oxygen flow rate substantially consists of O_2, and the argon flow rate substantially consists of Ar.

51. The method of claim 43, wherein the MTJ stack is over an underlying layer, wherein the underlying layer comprises conducting lines formed in an insulating layer, wherein the etching of the MTJ stack forms an MTJ over one of the conducting lines, and further comprising:

stopping the etching of the MTJ layers before reaching the conducting line; and

overetching into the insulating material with a fluorine-based etch chemistry.

52. The method of claim 51, wherein the fluorine-based etch chemistry comprises CF_4, CHF_3, and Ar.

53. The method of claim 51, wherein the etching of the MTJ stack and the etching of the insulating material are performed in a same chamber.

54. A method of fabricating a magnetic tunnel junction (MTJ) device, comprising:

providing a stack of initial layers over an underlying layer, wherein the stack of initial layers comprises a photoresist layer, a hard mask, an MTJ stack, the photoresist being over the hard mask, and the hard mask being over the MTJ stack;

etching the hard mask to form a hard-mask pattern therein in alignment with a resist pattern formed in the photoresist layer;

stripping the photoresist layer using a resist-strip plasma comprising oxygen;

oxidizing exposed surfaces of the hard mask during the stripping of the photoresist layer; and

etching the MTJ stack in alignment with the hard-mask pattern, the etching of the MTJ stack being performed using an MTJ etch chemistry at a total flow rate, and the total flow rate of the MTJ etch chemistry comprising a chlorine flow rate, an oxygen flow rate, and an argon flow rate, wherein the chlorine flow rate is about 20-60% of the total flow rate, the oxygen flow rate is about 10-40% of the total flow rate, and the argon flow rate is about 20-35% of the total flow rate.

55. The method of claim 54, further comprising:

oxidizing exposed surfaces of the hard mask after the stripping of the photoresist layer.

56. The method of claim 54, wherein the etching of the MTJ stack is performed in a high-density plasma reactor.

57. The method of claim 54, wherein the total flow rate is between about 50 and about 500 sccm.

58. The method of claim 54, wherein the etching of the MTJ stack is performed at a pressure between about 1 mTorr and about 20 mTorr.